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Representation and Reporting - D210

Reflection Paper

The medical_clean dataset was chosen for data representation and reporting in this project. According to the associated data dictionary, the primary objective is to identify the factors influencing hospital readmission rates to avoid being fined by the Centers for Medicare and Medicaid Services (CMS) for excessive patient readmissions. In this context, a readmission is defined by a patient being readmitted into the hospital within 30 days of their initial hospitalization. The dashboards are designed with colorblind-friendly visuals and filters, allowing stakeholders to analyze readmission trends from both the original and additional datasets. The presentation was designed for universal accessibility, utilizes effective storytelling techniques, and provides actionable insights tailored for each audience member.

The purpose and function of my dashboard align with the needs outlined in the data dictionary because the dashboard aims to identify the factors influencing readmission rates based on disability populations and age groups. The dashboard visualizes correlations between readmission rates and different population segments through various data representations and filters. One of the data representations uses donut charts to visualize the different segments of populations for each state and displays the average initial hospitalization days in the center. This adds more granularity for comparing readmission rates between the different population types compared to the visualizations that consider the United States (US) population as a whole.

Another visualization is a stacked bar chart that compares the readmission rate and average initial hospitalization days by population type at the national level. These different perspectives allow for a deeper understanding of the factors influencing readmission trends. Additionally, there are several filters to enable users to sort the visualizations by age group, disability type, and readmission status, further segmenting the data to uncover more insights.

As part of the assignment, the US Census Bureau S1810 Disability Characteristics dataset was incorporated alongside the medical_clean dataset in the data representations and reporting. This dataset segments the U.S. population by gender, race, disability type, and age group for each state. It complements the medical_clean dataset because the original dataset contains patient information regarding health problems, age, and home state. Therefore, the data could be aggregated on the state level to estimate the patient populations by likely disability type based on their health conditions.

It should be noted that the patients were assigned to the disability group they would most likely belong to based on their health problems, but this does not ensure that patients actually have that disability. This was done to simulate how hospitals treat patients with different disabilities, and there is some overlap as certain health problems can be associated with multiple disabilities.

This approach would offer insights on how readmission rates vary across different disability types and age groups, which could be valuable for the organization. For example, patients with self-care disabilities may have difficulty managing daily health needs after discharge, potentially increasing their risk of readmission. The following tables provide definitions and justifications for the grouping of patients into each disability type, based on their associated health conditions and supporting research.

Disability Type	Definition [1]
Ambulatory	Having serious difficulty walking or climbing stairs (DPHY).
Cognitive	Because of a physical, mental, or emotional problem, having difficulty remembering, concentrating, or making decisions (DREM).
Hearing	Deaf or having serious difficulty hearing (DEAR).
Self-Care	Having difficulty bathing or dressing (DDRS).
Vision	Blind or having serious difficulty seeing, even when wearing glasses (DEYE).

Ambulatory Disability

Health Problem	Justification
Back Pain	Back pain is recognized as a leading cause of disability worldwide, with physical complications like deformity and neurological deficits contributing to impaired mobility [2].
Arthritis	Osteoarthritis, a common form of arthritis, occurs when cartilage in the joints wears down over time. The loss of cartilage increases friction between

	bones, making movement painful and reducing the range of motion [3].
Overweight	"Whereas the greatest risk for physical disability occurs in older adults who are ≥ class II obesity… [4]. "
Diabetes	"The most common types of diabetic neuropathy are peripheral and autonomic…Peripheral neuropathy (also known as sensorimotor neuropathy), nerve damage that affects the feet, legs, or hands, can cause pain, numbness, and tingling in toes, feet, legs, hands, and arms, which may subsequently cause difficulty walking and holding onto objects. [5]"

Cognitive Disability

Health Problem	Justification
Anxiety	"Cognitive impairment (CI) is one of the most intensively studied aspects of pathological anxiety. Impairments in attention, executive functions, memory, cognitive deficit, as well as abnormal cognitions and metacognitions are identified in anxiety disorders. [6]"
Diabetes	"Studies have demonstrated that people who have diabetes, compared with people without diabetes, are more likely to develop cognitive problems. Older adults with diabetes have higher incidences of dementia, Alzheimer's disease, and vascular dementia External link than those with normal glucose tolerance. [7]"

Arthritis	"Cognitive impairment has been documented in several other rheumatic diseases, including conditions such as gout, 18 fibromyalgia, 19 and osteoarthritis. [8]"

Hearing Disability

Health problem	Justification
Vitamin D levels	"In conclusion, Vitamin D may have a significant role in the human auditory system, where its deficiency might affect both ears, in particular the inner ears where the sensorineural hearing loss occurs. [9]"
High Blood Pressure	"Repeated cases of hypertension accelerate the degeneration of vital hearing organs, causing permanent hearing loss. [10]"

Self-Care Disability

Health problem	Justification
Diabetes	Diabetes can cause nerve damage, leading to symptoms such as numbness or pain in the limbs. These symptoms can significantly impair a person's ability to perform daily activities, resulting in a self-care disability [5].
Overweight	"Cognition, communication, mobility, and self-care disabilities were each significantly associated with higher weight status. Moderate–severe obesity in particular was more prevalent among those with cognition, self-care, and

	mobility disabilities [11]."
Arthritis	"Because arthritis is the leading chronic condition for middle-aged and older adults, this profile of extensive but mild-to-moderate disability is experienced by many millions of adults. Accommodations for arthritis may also be extensive but aimed more toward self-care than toward assistive and medical services [12]."
Stroke	"All major strokes affect mobility, and in those whose mobility was already impaired this can lead to dependency on a wheelchair, or sometimes the need for residential care [13]."
Back Pain	"Approximately 75 percent of those with chronic severe back pain reported disability, with 60 percent noting mobility problems and work limitations, 34 percent self-identifying as having limitations with social participation, and 16 percent stating that they had limitations with self-care (getting dressed, washing, etc.) [14]."

Vision Disability

Health Problem	Justification
High Blood Pressure	"Nerve damage: Blocked blood flow damages the optic nerve. This can kill nerve cells in your eyes, which may cause vision loss. This is known as optic neuropathy. [15]"

Stroke	"About 65% of stroke survivors have vision problems [16]."
Reflux Esophagitis	"GERD is a form of reflux esophagitis, and pepsin, an enzyme associated with GERD, has been found in the nasal cavity, sinuses, saliva, and tears. Its presence in tears may contribute to eye issues like blocked tear ducts and dry eyes. This could potentially cause irritation, inflammation, blurred vision, or infections. These conditions could impair vision and be classified as a vision disability if they significantly affect daily functioning [17]."

The dashboard includes a map containing donut charts and a KPI table with interactive controls that executives can utilize to create effective strategies for reducing readmission rates. As previously mentioned, the donut charts visualize the population segments for each state and display the average initial hospitalization days at the center. Additionally, the tooltip reveals the readmission rates for each state based on the currently filtered disability type.

This visualization can be filtered by disability type, age group, and readmission status to highlight any differences in initial hospitalization days and readmission rates. This could be valuable because, as the population ages, the disabled population grows, and some of these disabilities affect patients' ability to manage their health.

The regional vice presidents can leverage this data representation to compare how readmission rates vary across hospitals in different regions for the selected disability types. This comparison can help identify hospitals with lower readmission rates, which may provide best practices and insights to assist hospitals in states with higher rates. For instance, patients from hospitals with lower readmission rates may have access to more resources and support for managing their disability, leading to improved outcomes.

The KPI table provides similar information to the donut charts but can be filtered by the top and bottom three states based on readmission rates. It offers the advantage of enabling comparisons across all disability types and age groups simultaneously. This allows the senior vice president of hospital operations (SVP), the vice president of research (VP) , and the panel of regional vice presidents (Regional VPs) to identify states with high readmission rates, compare population types and the performance of the top hospitals, and derive actionable insights to reduce readmissions.

The dashboard uses a color palette designed to accommodate the three most common forms of color blindness. These are protanopia (red color blindness), deuteranopia (green colorblindness), and tritanopia (blue-yellow colorblindness). People with protanopia or deuteranopia struggle to differentiate between red and green, while those with tritanopia cannot distinguish between yellow and certain shades of blue [18]. To ensure accessibility, a color palette was chosen using a special tool, provided by Coloring for Colorblindness, that simulates how the colors will be seen through these forms of colorblindness. The palette can be seen in *Figure 1*.
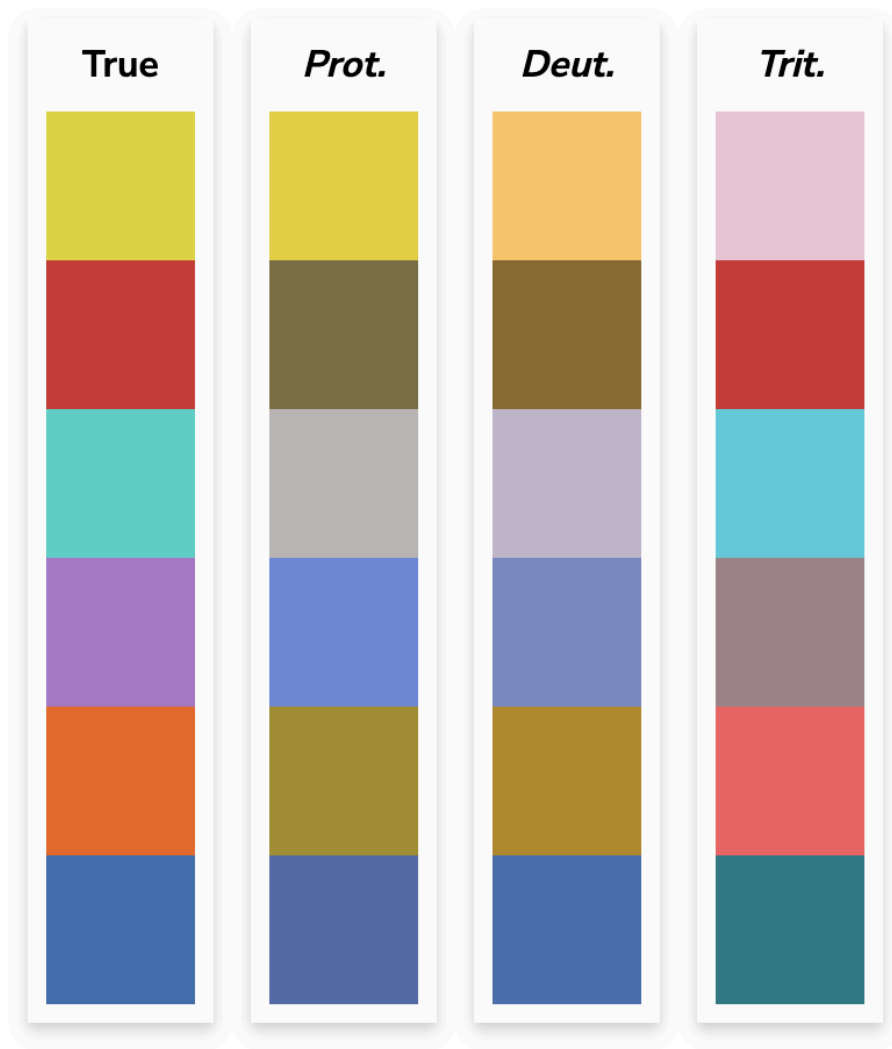
Color Palette

Figure 1: The left most column shows the original colors that were used throughout the dashboard. The top four colors were used together in the donut charts, and the bottom two colors were used in the other visualizations. The following columns simulate how these colors appear under different types of color blindness: protanopia (red color blindness), deuteranopia (green colorblindness), and tritanopia (blue-yellow colorblindness).

Two data representations that supported the story that I wanted to tell were the stacked bar chart and the donut charts. The story I wanted to tell through this dashboard starts with the correlation between initial hospitalization days and readmission rates. From this correlation, I added depth by segmenting the data into disability types and age groups to uncover how readmission rates differ between these populations.

The stacked bar chart illustrated the correlation by showing the average initial hospitalization days for readmitted and non-readmitted patients across age groups. Readmitted patients had an average initial hospitalization of approximately 17 days, while non-readmitted patients averaged 64 days. This trend was consistent across age groups and disability types on a national scale, suggesting that disability type alone does not significantly influence readmission rates. To provide a broader perspective, I further segmented these populations using donut charts, which added more granularity to the analysis.

Breaking down the populations by state revealed significant variations in readmission rates and average initial hospitalization days across different disability types and age groups. For instance, initial hospitalization durations for the same disability type varied by one to two weeks between states. This analysis helps stakeholders identify states with the lowest readmission rates, enabling them to develop targeted strategies to reduce these rates and avoid CMS fines.

In designing my presentation, I conducted an audience analysis to adapt the message effectively for executive leaders and stakeholders, including the SVP, VP, and Regional VPs. Each role required tailored insights to align with their specific responsibilities:

- **SVP (Senior Vice President of Hospital Operations)**: Oversees operations across all hospitals nationwide, so visualizations included a national summary of populations and readmission rates. From this perspective, it was discovered that there was an increasing

prevalence of disabilities among age groups. Therefore, it was recommended to the SVP that investing in research and interventions for the most common disability, ambulatory, could help address this widespread issue and ease overall healthcare strain.

- **VP (Vice President of Research)**: Focuses on research initiatives to uncover trends and improve patient outcomes. The data was segmented by state, age group, and disability type, adding granularity for targeted decision-making. This approach highlighted the correlation between average initial hospitalization days and readmission rates. As a result, it was recommended for the Vps to lead a team of data analysts to further explore this trend and uncover the factors influencing long initial hospitalizations.

- **Regional VPs (Panel of Regional Vice Presidents)**: Responsible for operations within specific states. Visualizations were utilized to emphasize state-level variations in readmission rates and initial hospitalization days across disability types and age groups. This analysis identified the states with higher readmission rates to recommend region-specific initiatives to reduce hospital readmissions and mitigate penalties from the CMS. Additionally, the presentation identified a difference in the density of populations for each state, so it was recommended to the regional VPs to allocate more resources to hospitals in these areas to ensure consistent patient care.

The presentation was designed to be universally accessible for all audiences by customizing the dashboards for mobile users and being easily accessible on Tableau Public. The dashboards used a generic phone model for mobile users. This size had the smallest measurements, so all phone sizes should be compatible with the dashboards. Additionally, there are navigation buttons to redirect users between dashboards. To improve interpretability for users, high-contrast color schemes, informative tooltips, legible fonts, and descriptive labels

were implemented. Uploading the dashboards to Tableau Public ensures accessibility without requiring an account, allowing anyone with the link to view them online or download them for offline use.

Two key storytelling elements implemented in the presentation were narrative progression and contextual imagery. The narrative progression is established by starting with the most informative visualization, the geographical map of donut charts. It provides crucial context about the distribution of populations and initial hospitalization days across the United States. This sets the stage for the more detailed breakdowns that follow in supporting visualizations.

The audience is guided through the analysis, with the prominent bar charts drawing immediate attention to the key metrics for the average initial hospitalization days for each age group broken down by readmission status. These visualizations are strategically positioned to emphasize the most important insights for the viewer.

The heat map and tabular data support the main visualizations by allowing the audience to dive deeper into the precise population counts for each demographic. This layered approach ensures the presentation maintains engagement by revealing information in a logical, easy-to-follow manner.

Building upon this foundation, the second visualization introduces a comparative KPI table. This allows the audience to compare and explore population counts across the two data sources. The ability to filter this table by top and bottom states based on readmission rates builds upon the established narrative by highlighting the best and worst states according to hospital performance. This signals to executive leaders which regions require focus, enabling them to analyze trends across geography, demographics, and readmission rates.

Contextual imagery refers to the medical/data themed images included in the background of the slides to help establish the scene and context for the analysis being presented. These visuals engage the audience by signaling that the content is grounded in real-world healthcare data and decision-making. The imagery also enhances the credibility and professionalism of the presentation.

In conclusion, the dashboards utilized multiple data sources and data representations to provide an in-depth analysis of the factors influencing hospital readmission rates. By starting with the high-level geographical context and progressively revealing more granular insights, the narrative guides the executive audience through a logical flow of information. The strategic use of visual hierarchy emphasized the stacked bar chart, making the key metrics apparent, while supplementary visualizations supported the overall narrative by exploring the data in greater depth, uncovering relationships between demographics, geography, and readmission rates. Furthermore, the presentation established the scene by utilizing contextual imagery, engaging the audience through visual cues that were relevant to the data.

Importantly, the dashboard was designed with universal accessibility in mind. From the mobile-optimized layout to the colorblind-friendly palette, the presentation caters to diverse user needs.

Recommendations were tailored to stakeholder roles:

- **Senior VP of Hospital Operations:** Invest in targeted research and interventions for the most prevalent disabilities, especially those increasing in frequency across age groups.

- **VP of Research:** Lead a data analysis team to investigate the correlation between initial hospitalization duration and readmission rates, aiming to identify contributing factors for extended stays.

- **Regional VPs:** Implement region-specific initiatives in states with higher readmission rates.

Together, these insights aim to reduce readmissions, ease strain on the healthcare system, and mitigate CMS penalties.

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